Telephone interview with CAPT C. Robert Valeri, MC, USN (Ret.), participant in Navy blood program during the Vietnam War, and current Director of the Navy Blood Research Laboratory in Boston, MA. Conducted by Jan K. Herman, Historian of the Navy Medical Department, 5 August 2004.

How long were you in the Navy before you retired?
I was in the Navy for 23 years.

Aren't you originally from New England?
I was born and educated in New England, and I've been here all my life.

What town are you from?
I'm from Leominster, MA, about 40 miles west of Boston.

Where did you go to school?
I did undergraduate at Tufts and then went to Harvard Medical School. I could never get into medical school at Harvard now, but when I matriculated from '54 to '58, it was possible for a person like myself to go to medical school there.

I was trained here and did my residency in internal medicine at the Boston City Hospital, and then joined the Navy in '62 and I've been here ever since. I just started my 42nd year here.

Wow! Now that's impressive. You obviously love what you do or you wouldn't be doing it for that length of time.

Oh, I think we've done a lot of interesting things which were supported by the Navy. Our research was very operationally oriented. I think we've made a lot of contributions in what they call transfusion medicine.

I was fully trained in internal medicine/hematology before I joined the Navy in '62. The Vietnam War was on and I was assigned to what was originally called the Blood Research Lab at Chelsea, which eventually became the Naval Blood Research Laboratory, an in-house lab supported by the Navy. We were there at Chelsea from '65 to '74, when they disestablished the Chelsea Naval Hospital.

We relocated the lab in '74, which is still at the 615 Albany Street site. When they disestablished the Chelsea Naval Hospital with the major reduction of activity at the Charlestown Navy Yard, we were originally going to relocate in the Fargo Building. But the place where we are now became available because the New England Nuclear Company donated this facility to Boston University. And the University then deeded the building to the Navy and we occupied and then renovated it. So we've conducted all our research from '74 to the present time at this facility.

During that time we did a feasibility study in Vietnam from '66 to '68 using the first method to freeze red cells. Over the past 40 years, we've dramatically simplified the technology. We have a license for freezing red cells for at least 10 years at minus 80 degrees centigrade.

The big breakthrough came on May 4th, 2001 when the FDA approved the technology that enabled us not only to freeze red cells but we could thaw, wash, and then store them for 2 weeks. And that was a major contribution because, up to that point, anything you did where you added something to blood and then removed that material from blood, required that you could only use the blood product for 24 hours, provided that you stored it at 4 degrees centigrade. We

freeze the cells at the temperature of dry ice and alcohol, and that is minus 80 C. Then we thaw the red cells and wash them, removing the additive--glycerol. Then we put them in a medium and store them at 4 degrees.

Prior to May 4th, 2001, the rule of the game was that blood products to which you added something and then removed it from that blood product, could only be kept at the 4 degrees centigrade temperature only for 24 hours because of the concern of bacterial contamination.

Then over the years, a technology was developed by a company called Haemonetics, a company we work with very closely. This technology allows you to add the glycerol, freeze the cells at minus 80 degrees C., thaw the cells, and wash them. But now after washing and resuspending them into media, you can store them at 4 degrees centigrade for 2 weeks. This was very, very important for the logistic requirements that we had to meet.

Why did it take so long to get this approval. After all, you had been playing with this back in the '80s?

Good point. Why did it take so long? It took so long because the great fear of anybody working with blood products is that you contaminate the blood product. If you donate blood--they put a needle in your vein. Obviously there's the possibility that you have some bacteria on your skin, which you may put into the blood. Everybody knew that if you took these blood products and kept them at high temperature. What I mean by high temperature in this context means room temperature. If you do this, the bugs grow. If you infuse this contaminated blood, the recipient could potentially die from this transfusion of an infected blood product.

Over the years, people developed a method to "sterilely dock" that is to allow one to take two blood products and using a sterile connector device, actually take the two tubes and bring them together without contamination.

In addition, they began using in-line filters where you take a liquid solution and put it into a system. They developed so-called 0.2 micron in-line filters, which would prevent contamination of the solutions that were being added or removed from the blood. Then they developed the functionally closed systems, whether they be centrifuges or non-rotating seal systems.

So there was a major introduction of technology that would reassure everybody that you wouldn't contaminate blood. This was a major breakthrough. Now when you go into blood banks, it is possible to pherese people to separate the blood products using these sterile systems. These were major contributions by many people. And we were just fortunate enough to be able to work with the technology and to get FDA approval. Our lab is licensed to provide frozen red blood cells for the military. And they are used in limited fashion by the civilian community.

But I think right now, and I'm positive, that eventually frozen red cells and frozen platelets will be used for inventory control. So at times, when blood is needed and when everybody's on vacation, and nobody is donating blood, it will be available. If you have simple ways to freeze red cells, platelets, and plasma, they can be used to control periods of time when no blood is available.

But the major, major introduction was the ability for the FDA to now agree that you can take blood like frozen red cells, thaw them, wash them, and store them for 2 weeks. That's a major contribution to inventory control.

So, you already have a safe, prescreened blood supply ready to be thawed, washed, and ready to be used or stored for 2 weeks.

For red cells. Platelets, we would normally transfuse within 6 hours of thawing. And the same thing with fresh frozen plasma. But the big, big breakthrough was the ability to remove the additive and store the red cells for 2 weeks. This now allows inventory control. Here in Boston, the donations have dropped dramatically and so if there's not enough blood they cancel surgery and that's very expensive. But if you have frozen products, which are frozen in a very simple manner, these are major contributions that will be incorporated into civilian and military medicine.

I want to take you back to 1962 when you just joined the Navy blood program. What do you remember about that early time.

This was before the deployment of troops to Southeast Asia. At that time, blood was being collected in a primary anti-coagulant, which only allowed the blood to be stored for 21 days. The entire attitude of the military, which was really driven by the Army, was that if you go into combat, the simplest way to provide blood is to obtain the blood from the troops. So they provided the bags required to draw the blood and they did the Landsteiner type testing. [Karl] Landsteiner got the Nobel Prize in 1900 for defining the ABO group. And that's how we fundamentally transfuse blood products.

At that time, the Army was very adamant that the simplest way to provide blood products was to use what they called the "walking blood bank." The Navy, however, was unique. It had ships and deployments where it would be difficult to maintain a walking blood bank.

About the time I entered the service, there was a tremendous amount of interest in developing blood substitutes. The major blood substitute introduced during World War II was human albumin--serum albumin. This was all brought about by technology designed and developed by a professor at Harvard University named Edwin J. Cohn. He developed the Cohn Fractionator which would allow you to isolate the albumin from the plasma, which the government then bought into and used as the resuscitative fluid.

About the time they were isolating these plasma proteins from blood, a paper was presented in Spain by Audrey Smith, a veterinarian. She described the ability to freeze fowl spermatozoa using glycerol. When Cohn came back from that meeting in 1954, he decided to freeze the red cells they were normally discarding. They were collecting whole blood, isolating the albumin, and discarding the red cells. They decided to use the Cohn Fractionator to add the glycerol to the red cells before freezing them.

When I showed up, we were using the Cohn Fractionator to take the whole blood, separate it, add the glycerol to the red cells, freeze the red cells, thaw the red cells, wash the red cells. This technology was then a research effort. It wasn't related to anything anyone would consider practical. But the principle was there. They could add a substance like glycerol. The most important thing I've learned over the years is that glycerol was a lucky choice because it became a safe substance to use as a cryoprotective. The toxicity of glycerol is only related to the fact it may damage the red cells. After you freeze you have to remove it from the red cells because within the red cells it acts osmotically. If you don't remove all the glycerol, those cells upon infusing will hemolyze. But the toxicity was never related to the glycerol itself. It was related to the fact you had not effectively added and removed the glycerol from the red cells.

When I arrived at Chelsea, the original Cohn Fractionator was a research tool that was being used extensively by a Navy captain named Lewis Haynes. He was a surgeon who was very interested in documenting the safety of glycerolized red cells. At that time, it became

apparent that the Navy had to modify the Cohn Fractionator concept and to upgrade it into a system that would be simple and usable.

You had mentioned Dr. Haynes. What was your relationship with him?

He was the commanding officer of Chelsea when I arrived and was very interested in utilizing frozen blood technology. He was the doctor who transfused, even before I arrived at Chelsea, over a thousand units of deglycerolized red cells to patients.

Did Dr. Haynes stay very active in that field while he was there?

He left Chelsea and retired. He was a very strong supporter of frozen blood technology.

At that time, they contracted a company called Arthur D. Little and its recently retired senior vice president named Jack Latham. He was assigned to make a disposable liner to replace the Cohn Fractionator. When I showed up, I knew nothing about blood because you never learn anything practical at medical school. I soon met Jack Latham. He was about 65 years old. In fact, he recently passed away at age 92. Jack Latham contributed to transfusion medicine what Landsteiner did by describing the ABO system.

He had retired from Arthur D. Little and, at his home in the cellar, began making the Latham Bowls. These were the first bowls introduced into transfusion medicine which would allow you to do a number of things. These bowls were needed primarily to add and to remove glycerol from the red cells. They had to be disposable; they had to be sterile. I gave this job to Jack Latham, who was then looking for a company to work with him. Eventually, he founded a company called Haemonetics.

So the bowls that Latham developed were the precursors of the Haemonetics deglycerolizing machine?

They were one and the same. Jack Latham was a genius who revolutionized blood banking. What was going on when I showed up at Chelsea? We were collecting blood initially in bottles and then plastic bags. We were trying to isolate from a unit of blood, the red cells, platelets, and plasma. Latham showed up and with his ingenuity and his ability as a very good scientist, designed a bowl, originally a stainless steel bowl. Then it was a polycarbonate bowl because you had to look into the bowl as you separated out the blood components. And you couldn't see through stainless steel.

Then, through his genius, he designed the so-called "Latham Bowl." This was a disposable bowl. We, in the military, were very interested in it because we certainly couldn't take the Cohn Fractionator and use it practically.

It was a big machine?

It was a monster. It was like the Statue of Liberty. Latham's technology just revolutionized blood banking because he took the bowl and was using it to add and remove glycerol. Then he got involved with platelet pheresis, plasma pheresis, leuco pheresis, and RBC pheresis. He then was able to convince everybody that it was safe to hitch a donor up to a spinning bowl, pass blood into this system, and give back to the donor the blood products that he didn't want, and isolate plasma, RBCs, and platelets. He did all that back in the mid 60s. We were very fortunate because we were here working with this company to develop a technology that could be used by the military.

What was the actual mechanical procedure? Was it a spinning device?

It was a centrifuge that separated the cellular components.

So it was the same principle that Cohn used in his fractionator.

Yes. He used a spinning reusable bowl which he put into a centrifuge. This was fundamental to both the Cohn Fractionator and all of Latham's developments.

This was blood that had been mixed with glycerol, frozen, and then thawed, cleansed, and . . .?

Exactly. But all that blood had been frozen and cleansed using the Cohn Fractionator before Jack Latham got involved to take the principle of centrifugation and developed it into what are called disposable systems, not reusable systems. The original Cohn Fractionator required that this machine be dismantled, washed, reassembled, autoclaved, and then reused. It was a very laborious method.

It was then our increasing involvement in Vietnam that spurred this work?

Yes. At the time I entered the service the Army had convinced itself that "walking donors" would be able to provide the blood. The Navy felt that with the development of the Cohn system and the freezing of red cells that in isolated areas frozen blood products could be used. And that was the major division in research funded by the Department of Defense. So the Army pursued liquid preservation of blood products while the Navy became very interested in frozen blood products.

The Army would then add a substance as a preservative and not freeze the blood?

Exactly. They were very interested in preservation in the liquid state at 4 degrees centigrade. They did not want to get involved in a complex technology. Freezing requires that you need an additive. You need a method to add the additives to the red cells. You then have to freeze the red cells so you need freezers. Then you need a technology that will simply remove the additive and allow you to store the cells. The Army pursued the simpler approach. If you wanted to donate a unit of blood, they decided to add something to the blood which would allow them to store it beyond 21 days. And that's what we began with. When I first went into the service, the length of storage of red cells was 21 days. Then as the Army pursued their additive methods to stabilize cells, the cells were collected as blood, stored at 4 degrees centigrade, but now they could be stored for 42 days. The main reason you could do that was by adding substances to the blood which allowed the red cells to maintain their biochemical profile so they could be stored for 42 rather than 21 days.

The Navy, on the other hand, was very interested in freezing red cells at minus 80 degrees. Originally we could store the red cells for 3 years. Now we can store them for at least 10 years. The big breakthrough, which I mentioned earlier, was the ability not only to add the glycerol and remove it, but now you an store the red cells for 2 weeks. That's a very, very important breakthrough. In our freezers, we only freeze O positive and O negative red cells--the universal donor red cells. If we wash them, we now have a 2-week period in which we can use them. In the past, prior to the putting together the three technologies I told you about, the main concern was keeping the products sterile. In the past you could only keep the blood product for 24 hours which limited its use.

And even though it may have been safe, since it wasn't approved it didn't matter.

Going back to the walking donors . . . In the past you could defend that. When the Brits went to the Falkland Islands, they had to decide how they would provide blood products. "Well, we'll just bleed the troops." Today, as you know, the entire preoccupation of mankind is with the testing of blood. If you go and donate a blood sample today, or if you donate a blood product, that product needs a minimum of 24 or 48 hours of testing before they release it because now there are a slew of infectious markers that you have to measure. You have to test the blood.

What you pointed out is absolutely true . . . Back about 5 or 10 years ago, the Department of Defense could make decisions as to what to do. But then there was a major change in philosophy where they decided that any blood product administered to any serviceman had to meet the same requirements established by FDA. So you could just forget bleeding the troops. There was no longer the "walking blood bank." You had to test the blood.

So you couldn't have the blood when you needed it.

That's exactly the point. There has been a tremendous change in attitude over the past four decades. And the regulations now demand that the blood products be tested. We now test for eight or ten infectious disease markers. You not only have to test the blood, but you have to get a history from the donor. And that history may eliminate him from the donor pool because he has been in an environment where he may be eating hamburgers that might transmit Mad Cow disease. So to reiterate: The Army stressed liquid preservation. The Navy stressed cryopreservation which now will ensure that you can quarantine blood products. The only thing we freeze are blood products you can give without requiring cross-matching. We only freeze O red cells. We only freeze AB plasma, and we only freeze single-donor platelets.

How big was the lab back in the '60s when you were at Chelsea?

It was relatively small because early on, we probably had eight or ten enlisted and Medical Corps working there at any one time.

As we got deeper into Vietnam . . .

We trained a lot of people. We conducted a feasibility study in Vietnam using frozen red cells. All the red cells were frozen at Chelsea, we shipped them to Vietnam, we trained all the enlisted and all of the military involved in that project, so that we were not only collecting and freezing the red cells, we were also transporting them to Vietnam. The people in Vietnam were trained in our lab. All the data was returned to our lab and we published a number of papers concerning the experience using frozen deglycerolized red cells in a combat zone. Some of what we did was published in the *New England Journal of Medicine* several years ago [1968].

What the lab actually did with regards to biology was really to define how you measure red cell and platelet survival and function. This was the area in which we made major scientific contributions. When I went into the service, much of this was not well defined. If we were to get credit, it would be for understanding what red cells do and how they function and circulate. And the same thing in regards to platelets.

Did any of this get beyond the study in Vietnam? Did they ever get a system up and running?

The fellow who was actually involved is Dr. Gerald Moss. He came back and now is a dean of the University of Illinois. He actually went to Chicago and established the frozen blood bank system there as an outgrowth of his experience using frozen red cells in Vietnam.

Was he in the Navy at the time?

Yes. He was a surgeon at Mass General Hospital and joined the Navy to get involved with this project. He was responsible for the frozen blood program at Danang and studied the patients who received the frozen red cells. When he returned, he established the frozen red cell bank at the University of Chicago. Following his years in the service, he became Chief of Surgery at the University of Chicago. For the past 20 years, he's been dean at the University of Illinois. Subsequently, he's been very actively involved in making hemoglobin based oxygen carriers.

The freezing technology was too complicated. Remember when I was discussing the attitude of the Army versus the Navy. Freezing brings into play a technology which requires freezers, cell-washers, solutions. When Gerry returned and was running a major study at the University of Chicago, he said, "Oh my God! This is very complicated. Why don't we just use the hemoglobin rather than the red cells themselves." That was the major stimulus for the entire field of hemoglobin based oxygen carriers.

So, back during the Vietnam era, the whole technology of frozen blood was extremely complicated.

It was very complicated. The original Cohn Fractionator could never be field tested. What we field tested was a system of washing the cells using a principle called agglomeration. If you take red cells and put them into sugar solutions, the cells will agglomerate. This principle was used by a surgeon named Charles Huggins. He was the son of a Nobel laureate. He was working at Mass General and introduced the principle of agglomeration to remove the glycerol. To do that required 6.7 liters of wash solution to remove the glycerol. This was the system that was field tested by Moss and our lab in Vietnam. There was a machine called an agglomerator. The red cells were frozen in huge bags which reduced the number of units you could put in the freezer. And then you needed all this wash solution. And the dating period on the deglycerolized cells was only for 24 hours.

Since then, we now have a completely automated system for adding and removing the glycerol, and storing the cells without any requirements other than to press a button. The volume of the wash solution has been reduced from 6.7 liters to 1.5 liters. That's a tremendous reduction in the volume of wash solution. We only freeze the RBC concentrate. We put the red cells in these rigid cardboard boxes and freeze them in a minus 80 centigrade dual cascade mechanical freezer. In Vietnam, we field tested water-cooled compressors. Now we use air-cooled dual cascade mechanical freezers. We don't need water. But now you can dramatically increase the storage capacity of any minus 80 degree freezer because we've reduced the volume of red cells frozen from x to a third of x. And now the wash solution is down from 6.7 liters to 1.5 liters. We can take these cells, deglycerolize them, put them in a medium, and store them for 2 weeks. So now the method of freezing red cells is very, very simple. Unfortunately, you need a freezer and a machine to do what I just talked about.

Do you still use the agglomeration process?

No. That was phased out. Agglomeration was introduced in the mid '60s and phased out by the mid '70s. Then Latham introduced his technology of the Latham Bowls.

Which was not based on agglomeration but on Cohn's principles.

That's exactly the point. The Latham methods for adding and removing glycerol, centrifugation, followed Cohn's principles, whereas Huggins introduced this very ingenious method of putting cells in glucose solutions where they spontaneously clump--agglomeration. But the method of washing with agglomeration is very, very inefficient because you have to use large volumes of wash solution.

And that's all you had in Vietnam.

Yes. When I went into the service, there were no sterile connectors devices approved by the FDA to connect plastic tubing together sterilely. That avoids you taking a stylette and entering the port. It means you have now eliminated the potential of contamination. That's the reason the FDA has approved storage of deglycerolized cells for 2 weeks. That's the most important thing to emphasize. The FDA has also approved the storage of red cells for 10 years. We know that we can store them for 37 years! But the FDA wants to know that the units that are frozen here--What's the history of the donor who donated the blood?

Did you ever work with Dr. Brodine back in the '60s?

Chuck Brodine was in Washington working at BUMED on this project and was the coordinator of all these things being done in Vietnam. He coordinated all the studies. He recruited all the individuals who were assigned to the Danang center for the research. He was the key man for the first feasibility study. In fact, he was a co-author of many of the early papers concerning using frozen blood in a combat zone.

Had you ever gone to Vietnam during that period to see how things were working?

I spent time there. I remember going to Vietnam at a time when the airlines weren't flying and it took me 4 days to get from Chelsea out to the West Coast. I was taking these military hops to go from one place to another. I then spent a lot of time in Subic Bay in the Philippines because one of my assignments was to see if we could find a company that could make the solutions that we were then shipping from Boston all the way out to Vietnam.

Did you ever find a company?

I found that the companies in the Philippines could only prepare small volumes of sterile solutions. We were providing them bottles which were being prepared at the Mass General Hospital pharmacy--3 liter solutions. For each unit we needed two 3 liter bottles. Our lab spent a lot of time working with Millipore Corporation to use membrane technology to prepare large volume parenteral solutions. We were asking whether it was possible aboard ship to take the potable water and make water for injection and to make the solutions to deglycerolize the frozen RBCs. We spent 5 or 6 years working with Millipore Corporation to make solutions. Then we eventually collaborated with the Army to make what we called "solutions at the site of need."

Was this the REFLUPS program?

Yes. All this came out of the experience in Vietnam. I trained all the guys who went to Vietnam and monitored all the data. But my major assignment was to see if I could find a company that could make these solutions for us, which I couldn't. So we decided to make them ourselves. We spent a lot of time and government money on membrane technology and ultimately the FDA told us they would only accept a large volume parenteral that had been heat sterilized.

So much for membrane technology.

It blew away membrane technology. I've got to say that after spending four decades here, I spent one of them working on the best way to provide solutions to remove the glycerol. The FDA wouldn't buy into it, even though our membrane technology would be allowed in an emergency. We have recently been working with a company called Applied Research Associates, which has been funded by the Office of Naval Research, to continue to explore the possibility of taking potable water and making water for injection and solutions that would be FDA approved. This is an extension of the REFLUPS technology.

What I have learned since I've been here is that the technology drives the research.

After you had gone to the Philippines to seek a company closer to Vietnam that could produce the fluids you needed, did you continue on to Danang?

Yes. We put a frozen blood bank there at Danang but we also deployed frozen blood banks aboard ships. I spent time at these various sites because I was responsible for training individuals to use the system and providing the frozen blood products. All frozen blood products came out of the Naval Blood Research Laboratory located at Chelsea. We also collected a lot of data on the patients who received the blood products.

What did the blood facility look like at Danang?

We housed the frozen blood bank in two trailers. We had a trailer where we had the mechanical equipment and a trailer which was the laboratory. At Danang we needed water and electricity so we had a generator and water running through the minus 80 degree freezers. We had the agglomerators there. We had the blood bank centrifuges in the trailer. With the two individuals we had trained at the lab to process the blood, Gerry Moss and his colleagues were transfusing the deglycerolized cells and in some patients they transfused 50 units of frozen RBCs. They did a very important study of casualties there who required blood. At the time we were doing the study, there were a lot of severely injured patients. They were able to take the frozen red cells, wash them, and transfuse them and saved individuals. It wasn't a huge study but during the time they performed the study, they found that the frozen red blood cells were safe and therapeutically effective. And they compared favorably to the liquid preserved red cells.

So you think it would be worth my while to get in touch with Dr. Gerald Moss and talk with him about it.

I think you should contact him. He's a dean at the University of Illinois. He was there for the entire study. He is the senior author of the paper that was published in *The New England Journal of Medicine*. When you speak to him, tell him that I recommended that you call him. He's a good friend.

Did they actually deploy some of the frozen blood on the two hospital ships?

Yes. They both had frozen blood banks.

And, of course, they had it at NSA Danang.

Yes.

Did they use it extensively or was it still experimental?

They used frozen red blood cells and that use was documented in an article in *The New England Journal of Medicine* I think in 1968. So all the frozen RBCs that were utilized were actually studied there by the people we trained and the recipients were also studied. In those studies, the frozen red cells were compared to the liquid preserved red cells.

The dating period of the blood at that time was 21 days. By the time it got to Vietnam, it had already stopped at the East Coast, the West Coast, and then Hawaii. And every place they tested the ABO. They were very concerned about proper transfusion of compatible RBCs to recipients. When I got to Vietnam, I realized that all the blood was pretty close to being outdated. Our lab designed methods to take outdated blood, to biochemically modify the RBCs, and to freeze the RBCs. That all came about by my visit to Danang where I saw that all the blood that finally got there was so old that they were discarding it. And they were all O Positive and O Negative red cells, which are universal donor cells. We designed systems that would allow one to add substrates to the cells and you could biochemically modify them or rejuvenate them by improving oxygen transport. As a result of this, we published a definitive paper back in '72 in *The New England Journal of Medicine* on the salvaging of outdated red cells. This has been a major contribution because of what's going on with all the blood currently going to the Middle East. With the new technology, which is the completely automated system, we can take outdated RBCs, which the FDA has approved, and rejuvenate and freeze the RBCs. We're now evaluating how long you can store the RBCs using this new functionally closed system after you thaw and wash them. The FDA has approved the storage of what we call non-rejuvenated RBCs and outdated rejuvenated RBCs. These can be frozen and stored for 10 years, you can thaw them, and now they can be washed and stored for 2 weeks.

The RBCs which are very important for everybody are the outdated O positive and O negative red blood cells. We are now rejuvenating these cells. The current dating period is 42 days for red cells. We can store them for as long as 45 days. Then we add a solution to biochemically modify the RBCs. Then we freeze, thaw, wash, and store them in these functionally closed systems for 3 weeks. We are trying to determine how long we can store these RBCs. That will be a major contribution because it will mean that as the donor pool decreases because of testing and donor deferral, you will be able to take RBCs that have been tested, and if they are outdated, you can biochemically modify and freeze them.

I want to thank you very much for spending time with me this morning.

I would be happy to provide you with any additional information. We did the feasibility study, learned the limitations, and were successful in dramatically simplifying the procedure to freeze the red blood cells. And we have worked to make resuscitative fluids and wash solutions at the site of need. We have to wait for the technology to be developed; we don't develop it. We just use it.